Seismic and electrical properties of rocks for monitoring the CO_2 storage, including laboratory experiments

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- Project duration: 01.12.10 – 30.11.14
- Supervisor: Dr. Ranajit Ghose
- Main research question: derive and experimentally validate the rock physics models for use in a combined seismic and electrical monitoring approach for CO_2 storage
- Relevance for implementation of CCS: prediction of potential hazards for the cap rock and CO_2 plume movement, determination of pressure build-ups
- Results: innovative lab facility has been developed, sensitivity of AC electrical measurements to CO_2 phase change and CO_2 front propagation has been investigated, upscaling approach has been derived, conversion of geophysical → reservoir parameters

Introduction

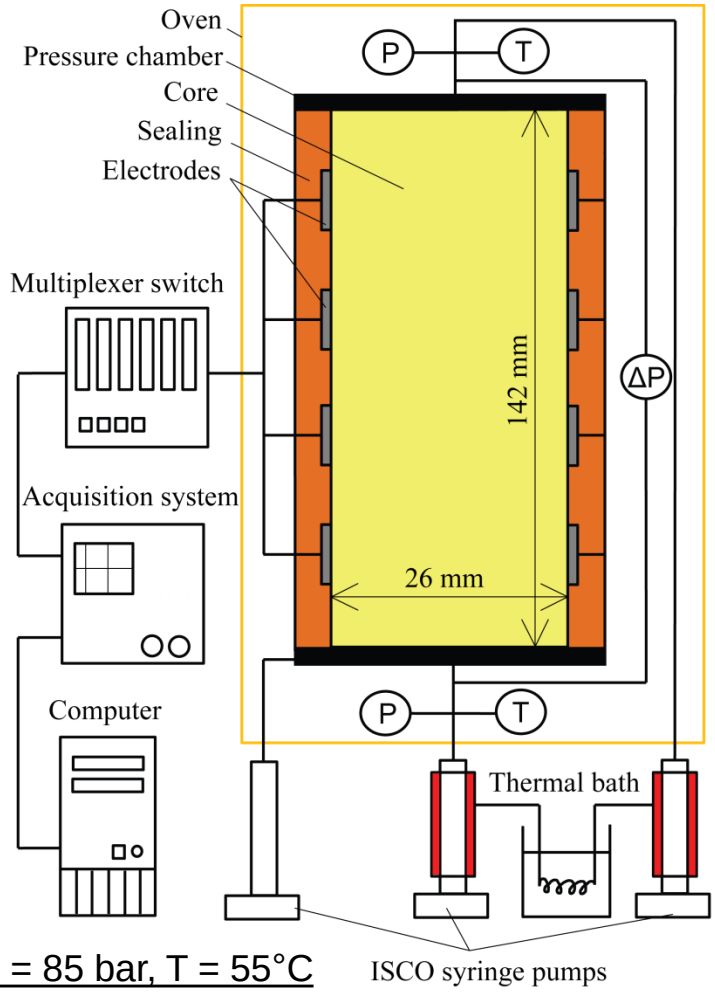
Importance of lab experimental studies:

- To facilitate the field data interpretation
- Check the possibility of monitoring CO_2 phase transition
- Better quantitative constrain on predicting the CO_2 front

Primary objectives:

- Develop a monitoring approach using integrated frequency dependent electrical and seismic measurements
- Check repeatability of the measurements and the parameter sensitivity through laboratory experiments
- Convert the laboratory measurements to the field scale

Method



P = 85 bar, T = 55°C

Setup output: Magnitude |Z| and phase φ of electrical impedance

Check: Sensitivity to CO_2 phase transition

Check: Sensitivity to CO_2 front movement

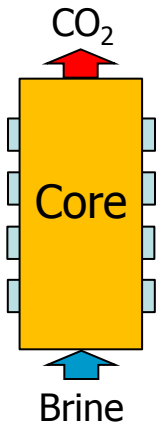
Upscaling

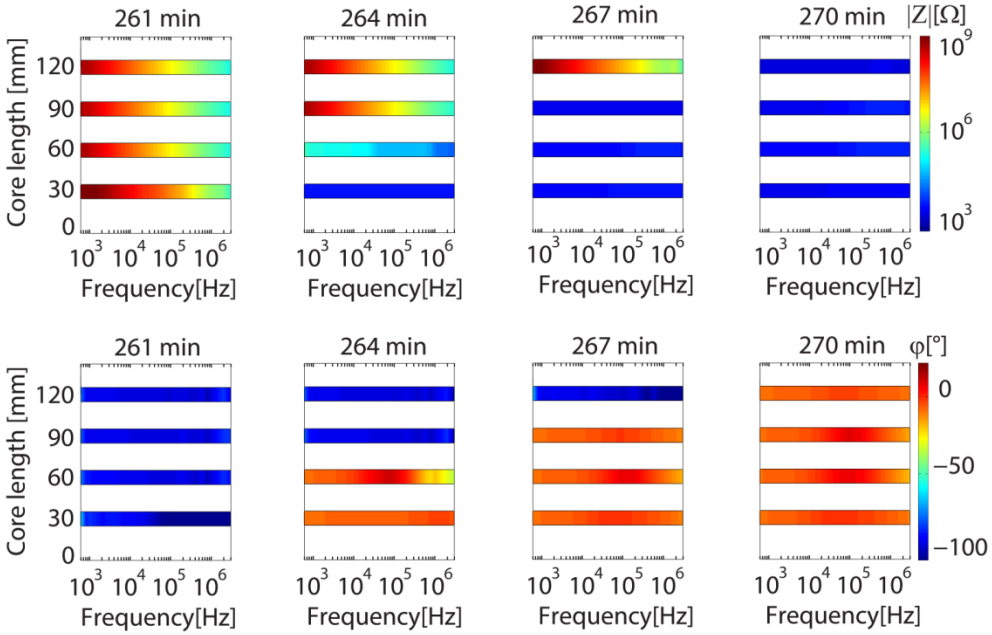
Inversion of porosity, permeability and CO_2 saturation from |Z| and φ

Results

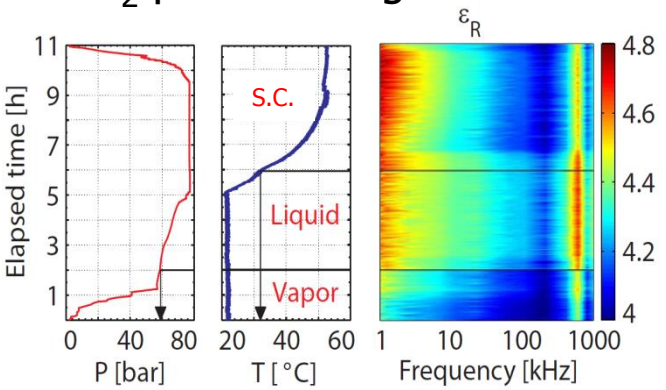
AC electrical measurements allow us to monitor:

- Brine displacing CO_2

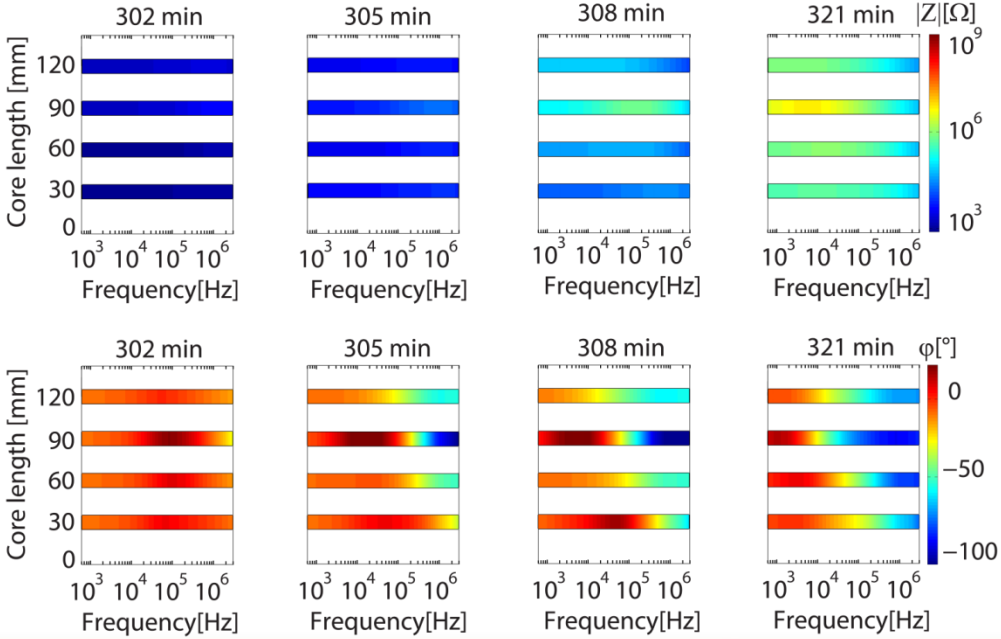




- CO_2 phase change



- CO_2 displacing brine



Conclusions

- From laboratory measurements, we have found that the real part of the electrical permittivity is quite sensitive to CO_2 phase change
- CO_2 front propagation can be monitored using complex electrical impedance
- Repeatable measurements appear possible
- The value of CO_2/brine saturation can be predicted in case both phase and magnitude of electrical impedance are reliably measured
- The obtained insights will be useful in reducing the uncertainty range in monitoring CO_2 reservoir parameters
- A robust upscaling approach is needed